OBSERVATIONS ON THE BEHAVIOR OF *PHILONTHUS ALUMNUS* ER. (COLEOPTERA: STAPHYLINIDAE, STAPHYLININAE)

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Abstract

Specimens of *Philonthus alumnus* Er., collected at blacklight in Bryan, Texas, were maintained in laboratory cultures. This beetle proved to be an aggressive predator on several small insects including *Drosophila melanogaster*, *Sinella curviseta*, *Heliothis zea* (1st instars), as well as other individuals of *P. alumnus*. Grooming behavior primarily consisted of unilateral rubbing acts in which the goal was to pass detritus anteriorly to the mouth for ingestion. Much of the grooming behavior appeared instinctive, but the beetle was able to make some adjustments if grooming structures were missing. The mating sequence was short with no elaborate displays; the male assumed an active role, while the female assumed a (for the most part) passive role.

Introduction

In America north of Mexico the genus *Philonthus* Curtis contains more than 140 species (Moore and Legner 1975). Little work has been done on the general biology and ecology of these species, and the systematics of the group is primarily in the descriptive phase. Many *Philonthus* species are commonly listed (usually as "*Philonthus* sp.") as predators of dung inhabiting flies (Bacchus and Hammond 1972, McDaniel *et al.* 1971, Merritt 1976, Sanders and Dobson 1966, and Wingo *et al.* 1974). Hinton (1954) briefly described the habits and general ecology of *P. sordidus*, *P. politus*, and *P. succicola*, all of which are predaceous on fly larvae. However, no reference to the habits or ecological characteristics of *Philonthus alumnus* Er. is made in these works.

According to J. M. Campbell (pers. comm.), *P. alumnus* is one of the most abundant species of *Philonthus* in North America. Moore and Legner (1975) list *P. alumnus* from New York, Florida, Missouri, Baja California, Arizona, S. California, and the West Indies, and Blackwelder (1944) also lists it from Mexico and Puerto Rico. *P. alumnus* occurs commonly in east-central Texas throughout the late spring and summer. Since I have been unable to find any account of the biology of this beetle, the present paper describes a series of behavioral observations which I have made under laboratory conditions.

Materials and Methods

Twenty-four specimens of *Philonthus alumnus* Er. were collected at blacklight in Bryan, Texas on May 14, 1976. The beetles were placed in a small plastic bowl (10.5 cm diameter X 5.0 cm high) containing a moist sand substrate. A tight fitting clear plastic lid was affixed to this chamber. The beetles were maintained in an incubator at 20° C and were fed *Drosophila* larvae as food. Most behavioral observations were made by placing the entire chamber under a dissecting microscope. Individual beetles were removed to smaller plastic chambers (5.5 cm diameter X 4.0 cm high) for observation of grooming behavior. A moist strip of white paper toweling was placed in each smaller chamber to facilitate observation and to serve as a substrate. Chalk dust or charcoal powder was then sprinkled with a small camel's hair brush on the dorsal surface of the beetles to induce grooming.

Observations on Behavior

The beetles spent most of their time roaming around the chamber (presumably in search of prey), or resting in sheltered areas such as burrows which they had formed in the sand or under small pieces of wood or rock. Unlike some predaceous staphylinids (*i. e.* many *Stenus* species) *P. alumnus* did not appear to be gregarious, the individuals maintaining as much distance as possible between themselves in the chamber. When contact between individuals was made, a minor bout of fighting often occurred.

Aggressive Behavior. Individuals of *P. alumnus* were highly aggressive towards one another. Contact occurred often in the chamber causing the beetles to chase, and on several occasions, battle one another. Most bouts were short, the attacked individual usually retreating. These fights normally lasted for only a few seconds, but occasionally lasted for ca. 2-3 minutes. The killing of one individual by another was never observed. However, in an earlier trial 4 specimens were placed in a small plastic chamber with no food supply. Two days later only 2 beetles were alive, and remains of the other 2 (legs, individual sclerites, elytra, etc.) were found scattered on the floor of the chamber. The following day only 1 individual was found alive. Thus it appears that *P. alumnus* may resort to cannibalism under crowded conditions in the absence of food.

Feeding Behavior. In the laboratory several small insects were accepted as food. These included *Drosophila melanogaster* Meigen (larvae, pupae, and adults), *Heliothis zea* (Boddie) (1st instar larvae), and a collembolan, *Sinella curviseta* Brook.

D. melanogaster larvae (all instars) were readily accepted as food and adult *P. alumnus* have been maintained on this diet for nearly 3 months. Depending on the size of the larva, complete ingestion took ca. 2-5 minutes. Intact pupae of *D. melanogaster* were accepted, but injured pupae (*i. e.* pierced with a dissecting needle, allowing the hemolymph to exude) were more readily accepted. *D. melanogaster* adults were eaten, but these were difficult for the beetles to capture; the entire insect (excluding wings and legs) was masticated and ingested. First instar *H. zea* larvae were readily accepted and completely ingested by *P. alumnus*. *S. curviseta* individuals were difficult to capture unless injured or, on rarer occasions, trapped by the beetles. However, when captured, the entire springtail was ingested. From these experiments it appears that *P. alumnus* will accept a variety of small, soft bodied insects as food.

Upon capturing its prey, *P. alumnus* quickly retreated to a secluded spot; however this behavior may be abnormal due to the crowded conditions in the chamber. On many occasions, individuals would attempt to arrest food from one another, leading to a violent food "tug-of-war". This behavior usually involved only 2 individuals, but occasionally 3 beetles would compete for the same food morsel. This activity led to pulling the food apart, each beetle retreating to a secluded spot with a small portion.

Mating Behavior. Mating of *P. alumnus* was observed on 6 different occasions. This consisted of a sequence of events in which the male assumed an active mode while the female assumed, for the most part, a rather passive role. The preliminary phase of the mating sequence was brief, lasting for several seconds only, while the genital phase lasted ca. 4 minutes. The post-copulatory sequence was initiated when the genitalia were unlocked and the male and female lost physical contact with one another. The sequence of events included in mating behavior of one pair of beetles is listed in Table 1.

The preliminary phase in the mating sequence consisted of what appeared as an attack on the female by the male. The male rushed toward the female and tried to mount her dorsally, while the female gave every indication of trying to escape.

The genital phase began when the male was successful in mounting the female, who at this time assumed a very passive role as the genitalia were coupled. Afterwards, the male stepped off the female and assumed an end-to-end posture with her. In this position the male's abdomen was twisted, but he was still able to maintain a normal up-right stance. This posture was maintained for ca. 4 minutes as the male

slowly and rhythmically undulated his abdomen, and the female continued her passive demeanor.

The post-copulatory phase usually contained grooming movements (rubbing the abdomen with the legs and oral grooming of the antennae and forelegs) by the male. Only rarely did the female exhibit grooming as a part of the post-copulatory sequence, as she most often retreated to a secluded spot and continued to feed (mating was observed only when the female was feeding).

Grooming Behavior. Grooming behavior is here used in the same context as developed by Valentine (1973). The term "clean" refers to patterns whereby an appendage is passed over the mouthparts (oral grooming), and the term "rub" refers to patterns involving the scraping of a leg over another appendage or body region. Thus, grooming behavior can be loosely defined as the action whereby particulate matter is removed from the body or an appendage through stereotyped cleaning and/or rubbing movements. In *P. alumnus* several grooming patterns were observed, the object of which was to pass detritus to the mouthparts for ingestion.

Cleaning. Except in rare situations, the only structures groomed via the mouthparts were the forelegs (tibia and tarsus only) and the antennae. The antenna was brought to the mouth by reaching foreward with the ipsilateral foreleg, placing the tarsus on top of the base of the antenna, and retracting the leg to its normal position. This action brought the basal segments of the antennae near the mouthparts allowing them to be grasped by the mandibles and maxillae. The antennae was cleaned from about segment 2 to the apex by pulling it through the mouthparts as the mandibles and maxillae worked in a chewing motion. The foretarsus and foretibia were cleaned by rapidly pulling them across the mouthparts, which again worked in a chewing motion. Only unilateral (one appendage at a time) cleaning was observed in *P. alumnus.*

	Female	Male
Preliminary Phase	1. Feeding in Open	
		2. Hiding in Crevice
	3. Walked Near Male	
		4. Appeared to Attack
	5. Attempted to Escape	
Genital Phase		6. Dorsally Mounted Female
	7. Stood Still, Continued Feeding	
		8. Locked Genitalia
	9. Stood Still, Continued Feeding	
		10. Dismounted, Assumed End-to End Posture with Abdomen Twisted
	11. Stood Still, Continued Feeding	
		12. Slowly Undulated Abdomen
	13. Stood Still, Continued Feeding	
		14. Unlocked Genitalia
Post-Copulatory Phase	15. Walked Away, Continued Feeding	
		16. Walked Away, Began Grooming

Table 1. Reaction chain illustrating sequence of events in the mating behavior of *Philonthus alumnus*. (see text for explanation)

Rubbing. Types of rubbing observed in ca. 10 different individuals of *P. alumnus* included antenna, eye, thoracic, foreleg, midleg, hindleg, and abdomen rubbing. The ultimate goal was to pass (via the forelegs) particulate matter to the mouthparts for ingestion. Dissection of the digestive tract after grooming clearly showed that detritus (in this case charcoal dust) was ingested.

1.) *Antenna Rub.* In *P. alumnus* this pattern was usually coupled with, and occurred as a continuation of, eye rubbing. The foretarsus was raised and brought forward such that its ventral surface contacted the dorsal side of the ipsilateral antenna. The tarsus was then scraped over the base of the antennae as the foreleg was extended. Afterwards, the leg was either returned to its normal position, or more often the tibia and tarsus were removed to the mouth for cleaning. Unlike many beetles (Valentine 1973), *P. alumnus* exhibited only unilateral antenna rubbing.

2.) *Eye Rub.* In *P. alumnus* this behavior involved raising the foreleg and making contact between its ventral surface and the posterior corner of the ipsilateral eye. The leg was then extended forward, scraping the eye with the tibia. This movement was often continued so that the eye and antennal base were groomed in one continuous motion. Afterwards, the leg was either returned to its original position or removed directly to the mouth for cleaning. Only unilateral eye rubbing was observed.

3.) *Thorax-Midleg Rub.* The dorsal surface of the thorax (pronotum and elytra) was groomed by unilaterally rubbing it with the mesotibia. Often, the first 2 abdominal tergites were groomed as a continuation of this pattern. Detritus was picked-up by the mesotibia and passed to the foreleg for ingestion (via the foreleg clean).

4.) *Foreleg-Foreleg Rub.* This rarely observed pattern involved balancing the body on the mid- and hindlegs while lifting and bringing the forelegs together under the head. Here the foretibiae were rapidly scraped one against the other such that detritus accumulated on 1 tibia only. The soiled tibia was then cleaned with the mouthparts.

5.) *Foreleg-Midleg Rub.* This grooming pattern, one of the most commonly observed in *P. alumnus*, allowed detritus removed from the thorax and abdomen to be passed to the mouth for ingestion. Success was accomplished by holding the midleg stationary (either in a raised or normal, depressed position) and rapidly rubbing all surfaces with the foretibia.

6.) *Midleg-Hindleg Rub.* Particulate matter removed from the abdomen by the hindleg was passed to the mouthparts via the mid-hindleg rub, fore-midleg rub, and foreleg clean. The hindleg remained relatively stationary, but was rotated in several directions so that all sides were rapidly scraped by the mesotibia.

7.) *Hindleg-Abdomen Rub.* Detritus was removed from all aspects of the abdomen by scraping it with the metatibia and metatarsus (both uni- and bilaterally). In unilateral rubbing, the abdomen was tilted toward the hindleg.

Effect of Amputation on Grooming Behavior. Because of the apparent importance of the mid- and forelegs in the grooming sequences of *P. alumnus*, 2 tests were conducted to see how grooming was accomplished in the absence of one of these appendages. Two beetles were lightly anesthesized with CO_2, and the midleg or foreleg was amputated from each specimen. After recovering from the anesthetic, these beetles were lightly sprinkled with chalk dust and their grooming success noted.

1.) *Midleg Amputee.* Both mid-foreleg and hind-midleg rubbing was attempted by this beetle. Afterwards, the foreleg was cleaned with the mouthparts as though it had removed detritus from the missing midleg. Due to the missing appendage the beetle was unable to remove detritus from the ipsilateral side of the pronotum and elytra. Attempts at the mid-hindleg rub were difficult to observe. (Even when the midleg was fully intact the hindleg moved very little. Therefore, the fact that the hindleg did not move in this test gave little indication of whether or not the beetle was attempting to groom the hindleg with the missing midleg.) However, when detritus was picked up by the hindleg, the beetle would eventually clean the ipsilateral foreleg indicating the beetle's attempt to complete the instinctive grooming sequence which passes detritus from hindleg to midleg to foreleg to mouth.

2.) *Foreleg Amputee.* This beetle made every attempt to use the missing foreleg in its normal manner. However, when this was not successful in removing detritus, alternate methods were employed. In lieu of the missing foreleg, the antenna was pulled into the mouthparts with the ipsilateral midleg, while detritus was removed from the midleg by cleaning it with the mouthparts or (on rarer occasions) rubbing it with the contralateral foreleg. This beetle was, however, unable to remove detritus from the ipsilateral eye.

Discussion

P. alumnus is a highly predaceous staphylinid. Indirect evidence for this evaluation is seen in many phases of its behavior: i) the attack-like pattern of the male during the preliminary phases of the mating sequence, (ii) the spacing-out of individuals in the observation chamber, and (iii) the apparent cannibalism in the absence of a food source. Direct evidence for this evaluation is seen in the beetle's willingness to accept a wide variety of small insects as food (Collembola, lepidopterous larvae, and *Drosophila* larvae, pupae, and adults).

The female's elusive behavior (during the preliminary phase of the mating sequence) is similar to that of other individuals when protecting their prey from competitors. Thus, the female may not be trying to elude the male's copulatory endeavors, but rather, she may be simply attempting to defend her prey.

Most grooming patterns in *P. alumnus* are unilateral and the ultimate goal is to pass detritus to the mouth. This feat is accomplished by relaying (from one appendage to the other, or through direct oral cleaning) particulate matter anteriorly to the mouth. Dissection of the digestive tract clearly shows that much of this detritus is indeed ingested.

P. alumnus apparently has several preadapted mechanisms allowing it to compensate for missing grooming structures. Since the beetle attempts to use missing appendages in their normal grooming sequence, it appears that much of this behavior is instinctive. However, the inability of *P. alumnus* to remove detritus from the eye (Foreleg Amputee) illustrates the extreme importance of the appendages in the overall grooming success of this beetle.

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FIRST NEW YORK RECORD FOR *CARABUS MAEANDER* FISCHER (COLEOPTERA, CARABIDAE)

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Abstract

Carabus maeander was found in large numbers in Clinton County, New York. Of the 23 specimens collected, 2 females had full wings. This is a new state record.

Lindroth (1961) gave the range of *Carabus maeander* Fischer in the United States from Minnesota to Maine. Adult specimens are herein reported from New York for the first time.

Twenty-three specimens were collected in Clinton County in the Peru area. Many beetles appeared each night from April 17th. through April 20th. (1976) in a crushed stone driveway and on an adjacent lawn, both of which were illuminated by a street light. The collection dates coincided with the first few extremely hot days of spring, however, the beetle did not reappear on subsequent nights, following low temperatures and a snowfall. Seventeen of the 20 specimens collected were examined for wing condition, and one female had full wings.

C. maeander was taken in pitfall traps in July, 1976 at two semi-open (*Cornus* spp.) collecting sites, one fully winged female on Valcour Island, Lake Champlain and two males in Valcour, New York, directly opposite the island.

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Lindroth, C. H. 1966. The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska. Opusc. Ent., Lund, Suppl. XX, p. 1-200, part 2.